U.S. DEPARTMENT OF AGRICULTURE - FOREST SERVICE
CALIFORNIA FOREST AND RANGE EXPERIMENT STATION
Division of Forest Insect Research

Progress Report

EFFECT OF DEFOLIATION BY THE DOUGLAS-FIR TUSSOCK MOTH ON GROWTH AND MORTALITY OF WHITE FIR

1956 and 1957 Studies

By Boyd E. Wickman

SUMMARY

In August 1956, a study was begun to determine the effects of defoliation by the Douglas-fir tussock moth on growth and mortality of white fir on the Stanislaus National Forest, California. To carry on this study a series of 23 one-half-acre, circular, tagged-tree plots were established on the Stanislaus N.F. and intermingled private land by a forest insect survey crew. These plots coincided with 3 intensities of tussock moth defoliation designated as light, moderate and heavy and are located on the Summit Level Ridge, Thunder Hill, Lily Creek and Hell's Mt. units. The plots are to be used for a study area over the next five years.

From August 12-19, 1957, the plots were checked for mortality. The plots on the heavily defoliated unit, Hell's Mt., had 21 percent of the white fir killed. The other units had very little mortality. During this period J.E. Patterson's 1937 tussock moth plot on the Inyo National Forest was found and the corners marked.

INTRODUCTION

In 1956, ten thousand acres of white fir on the Stanislaus N.F. were aerially sprayed with DDT and diesel oil to control an infestation of Douglas-fir tussock moth, Hemerocampa pseudotsugata McD.[1/] The infestation was first reported by Station entomologists in 1954. This was the first substantiated occurrence of this species of tussock moth on the Stanislaus N.F., though it was known to have occurred on the Inyo and Modoc N.F. in 1934-1938. Subsequent checks of the Stanislaus N.F. in 1955 and 1956 indicated that white fir was defoliated severely by the insect and that a control operation was warranted. During June and July 1956, the areas of infestation were surveyed and population levels sampled. In late July and early August, the aerial spray program was successfully completed.

1/ Control of an infestation of the Douglas-fir tussock moth with DDT aerial spray, Calaveras and Tuolumne Counties, California, by R.E. Stevens. Berkeley, Calif., Feb. 1957.

Very little is known about the effects of defoliation by this insect on the growth and mortality of white fir. Local forest managers are interested in knowing how severely a tree must be defoliated before it will die so they can arrange cutting plans accordingly. It is also important to know the amount of growth loss occurring after an infestation, both from the viewpoint of monetary value of lost increment and the relationships of control costs to benefits gained. Therefore, it was felt that further studies of the extent of damage caused by the insect would be desirable, and that these studies should include a tally of tree mortality attributed to the tussock moth and a measurement of the reduction of annual increment caused by the defoliation.2/ To make such studies it was decided to establish a series of permanent tagged-tree plots throughout the infestation. This was done during August 1956 by a CF&RES forest insect survey crew composed of J.H. VrMeer, J.C. Tappeiner, J.D. Zachry and B.E. Wickman.

During the period of August 12-19, 1957, B.E. Wickman examined the tagged-tree plots for mortality and defoliation of white fir and located and examined J.E. Patterson's 1937 tussock moth study plot on the Inyo N.F.

PLOT ESTABLISHMENT - 1956

Location of the plots

The infested areas consist of seven units of varying acreage strung out in a 35-mile chain. They are on the westside of the Sierra, parallel to the crest, at an average elevation of 5,000 feet (see map). These areas are generally in pure white-fir type on ridge tops, and vary in size from 350-5,900 acres. Each separate area was given a unit name for the control project and the unit names were retained for the plot establishment.

In order to have a representative sample of several degrees of defoliation, plots were established in 4 units, each of different defoliation intensity. These defoliation intensity classes are designated as heavy, moderate, and light. The same classifications are used for the plots with the following requirements: a majority of the white fir on a plot had to be defoliated 50 percent or more to be a "heavy" area, 25 percent - 50 percent to be a "moderate" area, and 25 percent or less to be a "light" area.

The southernmost units had the heaviest defoliation, which decreased in the northern areas. The units used for plot locations, reading from south to north are Hell's Mt., plots 1-9, "heavy"; Lily Creek, plots 10-16, "moderate"; Thunder Hill, plots 17-21, "moderate and light"; and Summit Level Ridge, plots 22-23, "light". Plots 20 and 21 are located on Pickering Lumber Company land; plots 22 and 23 on Calaveras Land and Timber Company property; and the remainder are on the Stanislaus N.F. The plots are referenced to permanent roads and road junctions and are always clustered within a few chains of each other on side roads (see plot location maps).

2/ Study Plan for Determining the Effect of Defoliation by the Douglas-fir Tussock Moth on Growth and Mortality of White Fir on the Stanislaus National Forest, California, by B.E. Wickman, Berkeley, Calif. Dec. 1957.

Method of plot establishment

Once an area with the proper degree of defoliation was located, a cluster of 1/2-acre circular plots was established. The number of plots in the cluster varied from 2 in the northernmost, smallest and least defoliated units to 9 in the southernmost, largest and heaviest defoliated unit.

A three-man crew established the plots in the following manner: First, a yellow plot location poster was placed on a thrifty tree next to the road. The marker shows the number of plots in the cluster and directions to the nearest plot. The crew then proceeded to the area of the first plot. A white fir was always used for the plot center. One man painted the plot number on the north side of the tree, then paced out 83.3 feet (the radius of a 1/2-acre plot) from the center. A second man with a ball of string "tied on" at that point. Meanwhile the third man paced out 83.3 feet from the center, 1/2 chain, ahead of the stringman. Two members of the crew repeated this pacing of 83.3 feet from center until the string man had circumscribed the plot.

After the plot boundary had been established, the tree numbering began. One man with a pressurized paint can proceeded to number all white fir on the plot, 6.6 inches d.b.h. and larger, starting with the center tree as number one. The numbers are on the north side of the tree immediately above a "breast high" mark used for taking d.b.h. On plot 9, red fir was numbered, measured and appraised. On plots 10 and 11 all tree species were numbered and measured. (This was discontinued because of the increased time of establishing a plot.)

While this was being done, the other 2 men recorded the information listed below on the numbered trees. After all the larger trees were numbered, a 1/40-acre, circular subplot was established by pacing 18.6 feet from the center of the main plot to locate the boundary. Stripes or numbers were painted on each fir over 1-foot high and under 6.6 inches d.b.h. The number or the number of painted stripes on the stem designated the identity of the tree in the subplot. Then the trees were measured for diameter at the lowest stripe and information recorded. The numbering man normally finished first, so he proceeded to the next plot site, established the center and paced out to the boundary. The rest of the crew caught up with him at this point and repeated the process described above.

Information recorded on each plot

Each plot was given a number, 1-23 consecutively, defoliation intensity determined, and crew and date of establishment noted. The following information was recorded for each live, white fir in each plot. (See attached Recording form.) Tree number; species (white fir only, for most plots); d.b.h. (the nearest tenth of an inch); crown class (dominant, codominant, intermediate or suppressed); percent of crown defoliated in 1955; percent of crown killed in 1956 (estimated to nearest 5 percent); if dead - killed by and date. The trees in the subplot were classified the same way, but if they were too small to be measured by diameter at the paint stripe they were measured for total height.

Examination of 1/2-acre tagged-tree plots

From August 12-16, all of the tagged trees on the plots established in 1956 were checked by B.E. Wickman for evidence of additional defoliation, mortality and top-killing. There was very little evidence of insect feeding on 1957 foliage, and no Douglas-fir tussock moth larvae, pupae or adults could be found. The amount of mortality for 1956 by unit or defoliation intensity class is tabulated below:

Mortality of White Fir[3/] by Cause, 1956

Defoliation intensity class	Total no. trees on plots	Killed by defoliation alone		Weakened trees killed by other insects	
		No.	% total mortality	No.	% total mortality
Heavy plots 1-9	413	21	24	65	76
Moderate plots 10-16	297	0	0	1	100
Light plots 17-23	254	1	50	1	50

3/ Includes trees 6.6 inches d.b.h. and over and red fir on one plot.

As was expected, the greatest amount of mortality occurred on the heavily defoliated area, plots 1-9, the Hell's Mt. Unit. Most of the trees on these plots were defoliated 50 percent or more at the time of the initial classification in 1956. The amount of mortality caused by 100 percent defoliation of the tree was also quite heavy on these plots. Mortality from this cause will be reflected only in the 1957 cruise data, for subsequent mortality will probably consist mostly of weakened trees killed by other insects. Mortality figures for the moderate and light plots are insignificant, but that is to be expected. The damage to the trees in these plots will show up in the radial growth measurements.

Mortality of small white fir (6.5 inches and under) in 1956, which is not tabulated here, was very similar to the results shown above. Twenty-eight percent of the subplot trees were killed on plots 1-9, six percent on plots 10-16, and none on plots 17-23.

Examination of Patterson's tussock moth plot

After a day long search, the location of Patterson's 1937 tussock moth plot on the Inyo was believed found. The trees were evidently not marked in any way,

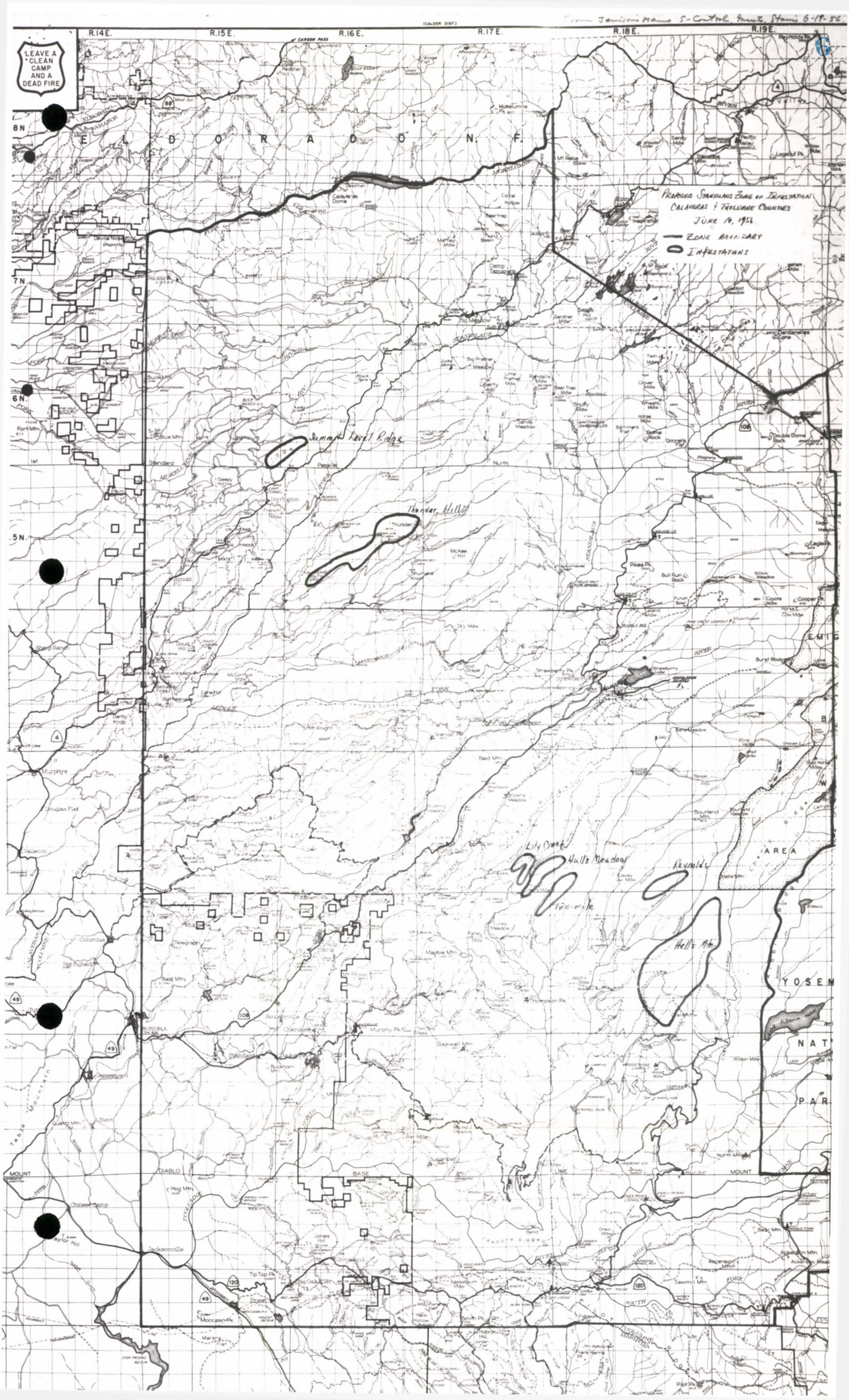
and there have been some changes in road location; but the area agrees with Patterson's map - except for section number (his section would place the plot in the village of Mammoth). Three of the corner trees were probably found. The exact location of the plot is not too important as long as a sample of cores can be taken from an area which was defoliated in 1937. This could show the period of growth reduction after an infestation by a comparison with non-infested tree cores in the same area. The plot has the appearance of past tussock moth defoliation, with white fir snags on the ground and most of the larger fir top-killed. Several cores were taken from mature, top-killed white fir, and the rings showed a marked decrease in growth in the middle 1930's. The two corner trees next to the road were marked with a painted X and a yellow plot location poster was placed on a young roadside tree (see map).

Berkeley, California
January 8, 1958

Boyd E. Wickman,
Entomologist

Attachments - 10 11

Agriculture--Forest Service, Berkeley, Calif.

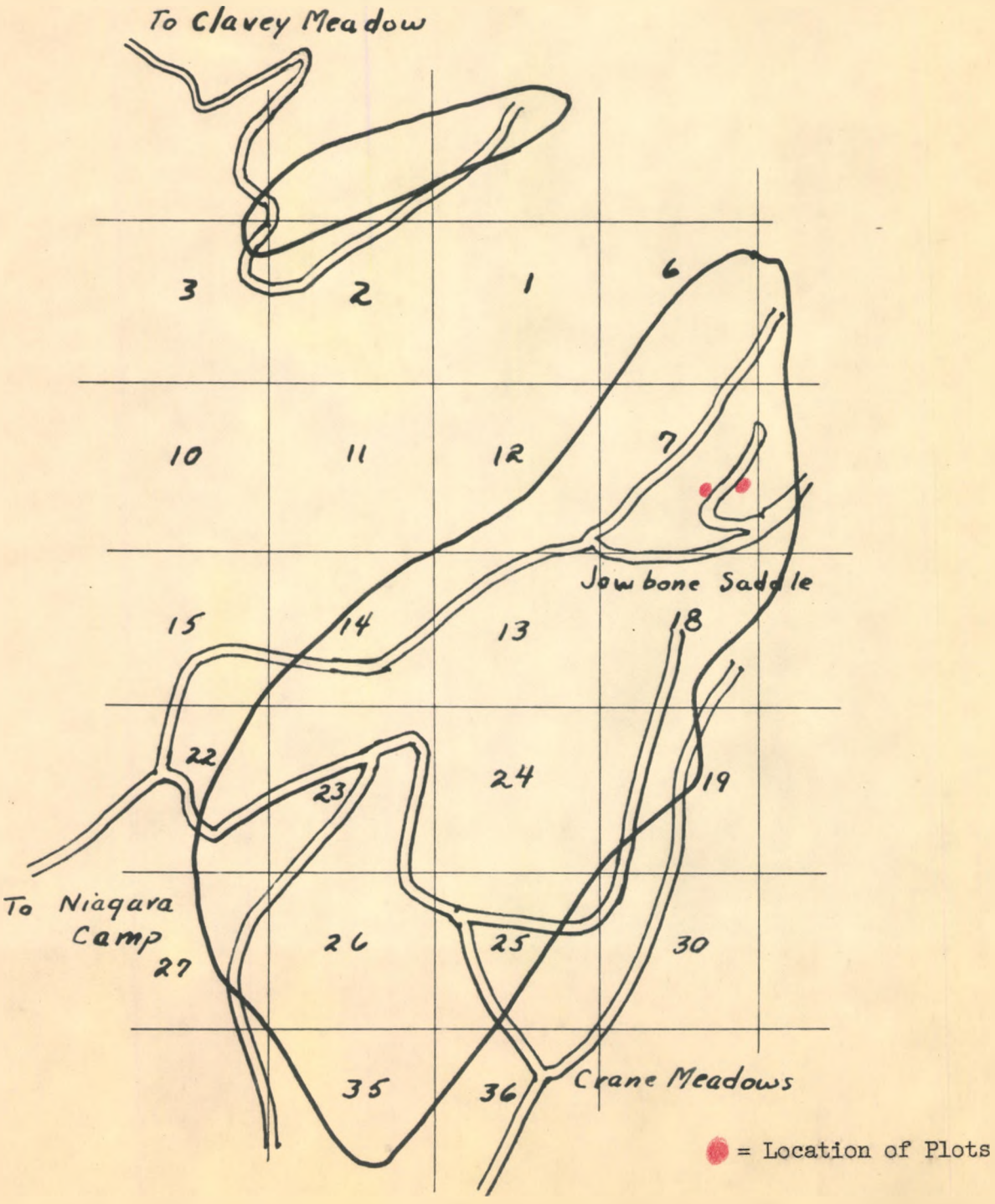

LEAVE A CLEAN CAMP AND A DEAD FIRE
R.14E.
R.15E.
R.16E.
R.17E.
R.18E.
R.19E.
8N
7N.
6N.
5N.
E L D O R A D O N. F.
PROPOSED STANISLAUS ZONE OF INFESTATION
CALAVERAS & TUOLUMNE COUNTIES
JUNE 19, 1956
ZONE BOUNDARY
INFESTATIONS
Summit Level Ridge
Thunder Hills
Lily Creek
Hull's Meadow
Reynolds
Two-mile
Hell's Mtn
AREA
YOSEM
NAT
PAR
DIABLO
BASE
LINE
MOUNT
Jamestown
Jacksonville
Sonora
Columbia
Murphys
Douglas Flat
Vallecito
Table Mountain
Standard
Parallel
North
Arnold
Blue Mtn
Fort Mtn
Sheep Ranch
Big Meadow
Camp Tamarack
Double Dome Rock
Eagle Pk
Pikes Pk
Burst Rock
Baid Mtn
Dockwall Mtn
Buckhorn Mtn
Hog Mtn
Jones Hill
Tip Top Pk
Moccasin Pk
Sawmill Mtn
Ackerson Mtn
Bear Mtn
Pilot Pk
Hobron Hill
Smith Pk
Big Oak Flat
Chinese Camp
Taylor Hill
Quartz Mtn
Mt Knight
Mt Lewis
Maple Mtn
Thompson Pk
Murphy Pk
Two Bar Grass
Wilson Mdw
Lawson Ridge
Pilot Creek
Tuolumne
Stanislaus
Calaveras
Mokelumne
Reynolds
Sonora
Jamestown
Arnold
Angels Camp
Valley Springs
Ione
Jackson
Volcano
Pioneer
Mokelumne Hill
San Andreas
Murphys
Columbia
Sonora
Jamestown
Angels Camp
Valley Springs
Ione
Jackson
Volcano
Pioneer
Mokelumne Hill
San Andreas

Stanislaus Tussock Moth Project

Reynolds & Hell's Mtn. Units

July 5, 1956

Scale 1" = 1 mile

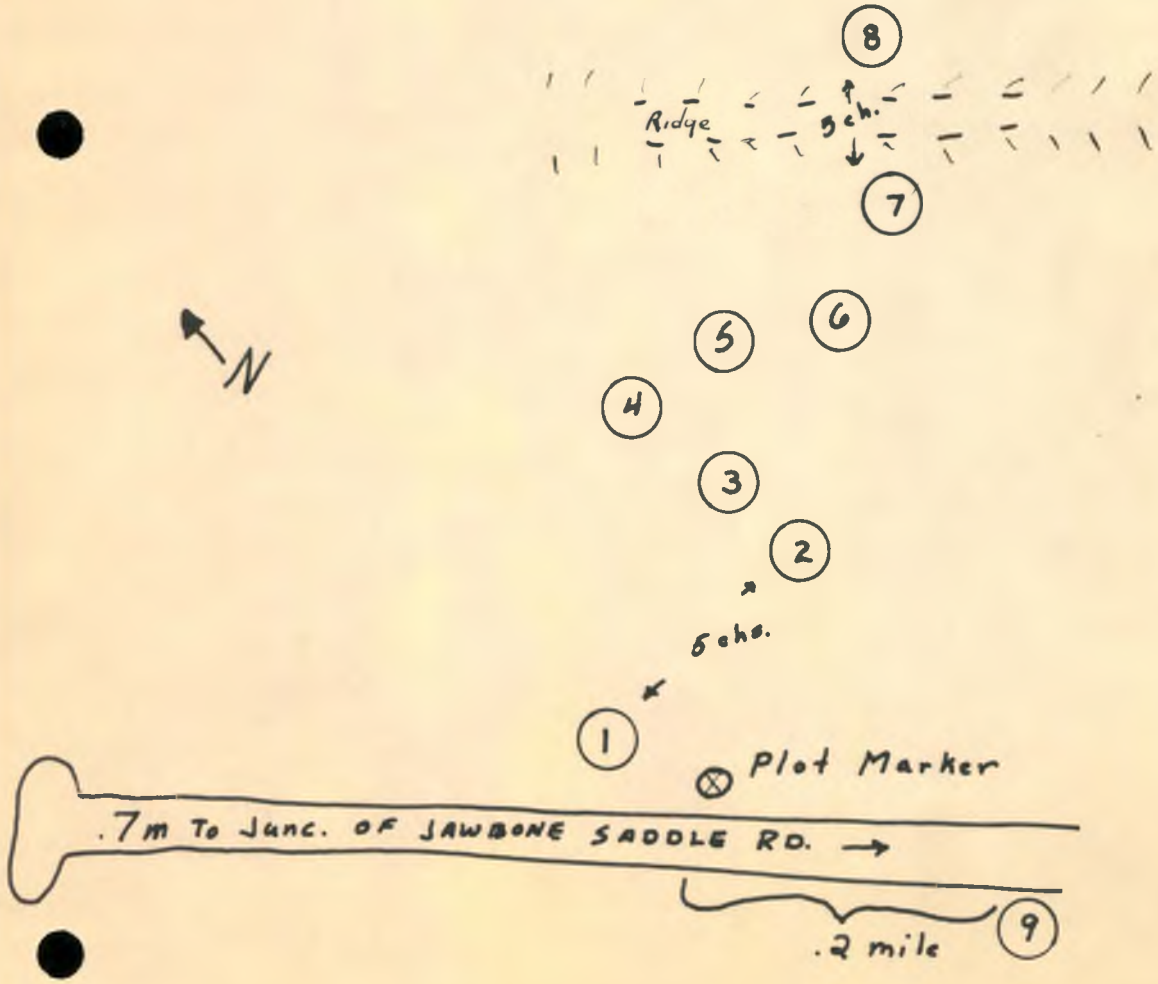


Tussock Moth Study Hells Mt. Unit

Location of Plots 1-9

R 19 E, T 2 N

Sec. 7

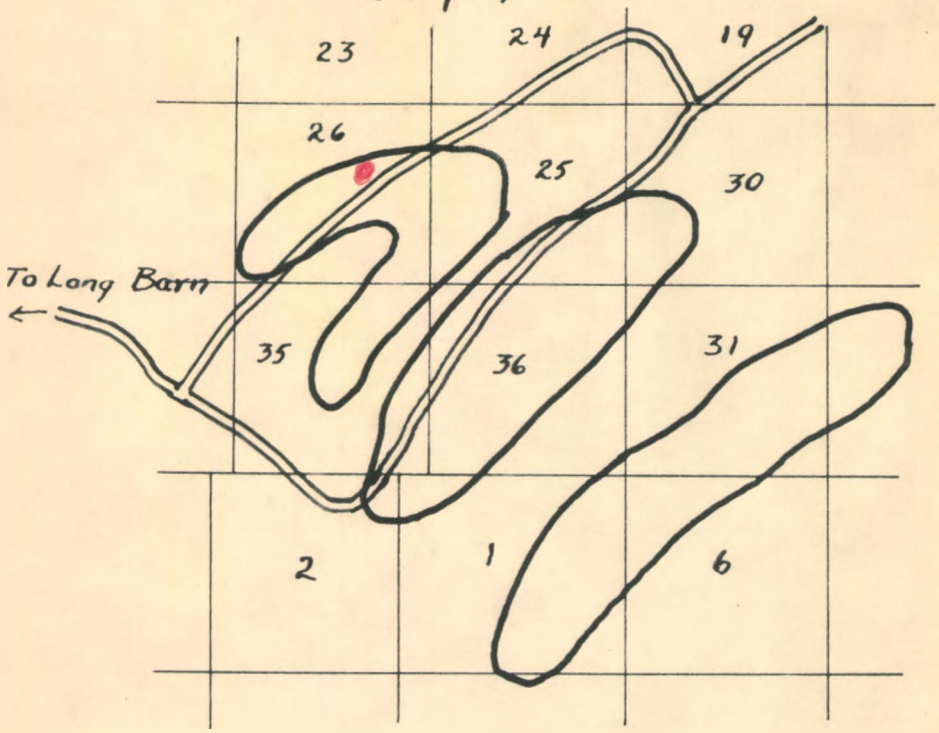


Stanislaus Tussock Moth Project

Lilly Creek, Hulls' Meadows and Two-Mile Units

July 5, 1956

1" = 1 mile



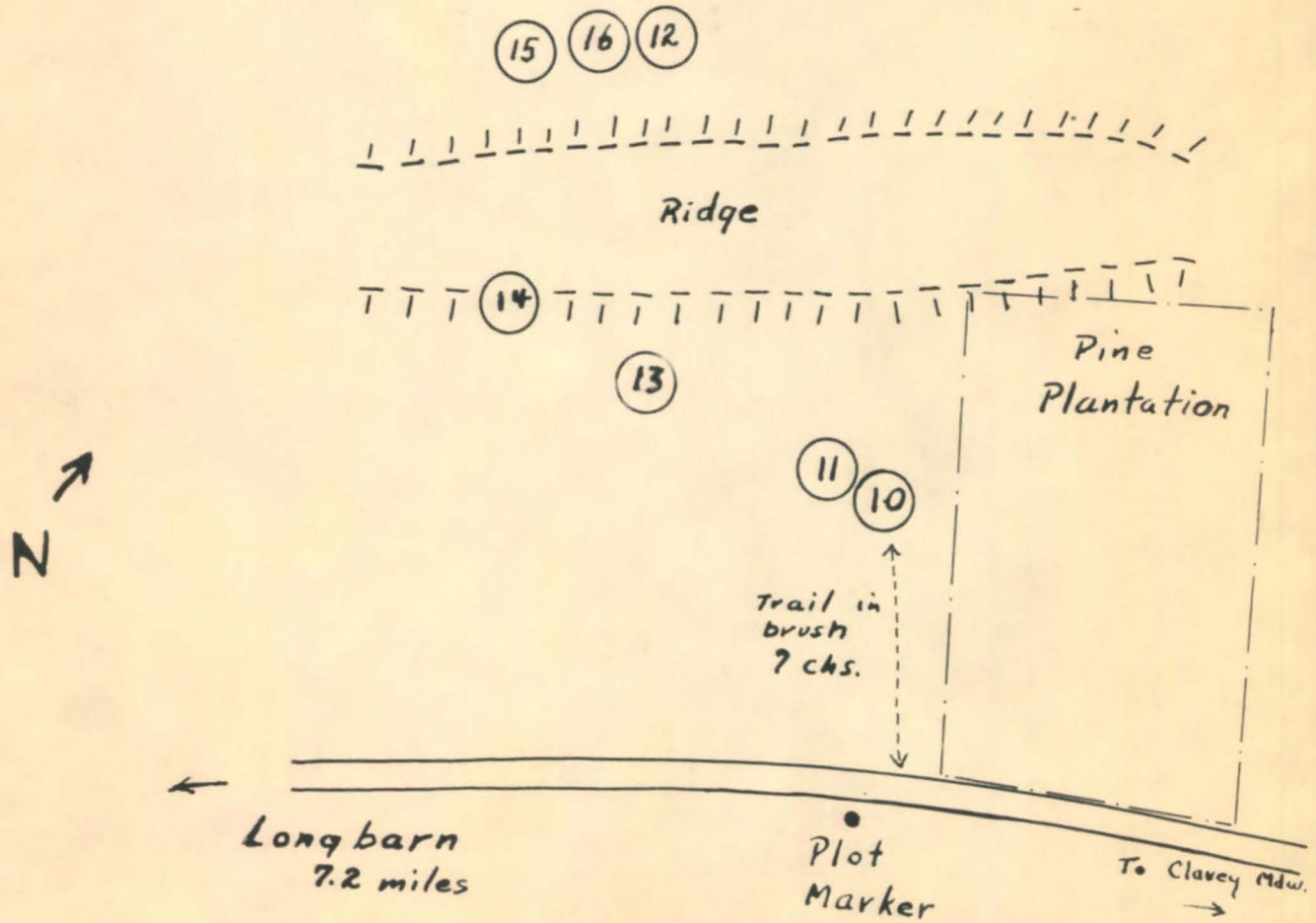
● = Location of Plots

Tussock Moth Study Lilly Creek Unit

Location of Plots 10-16

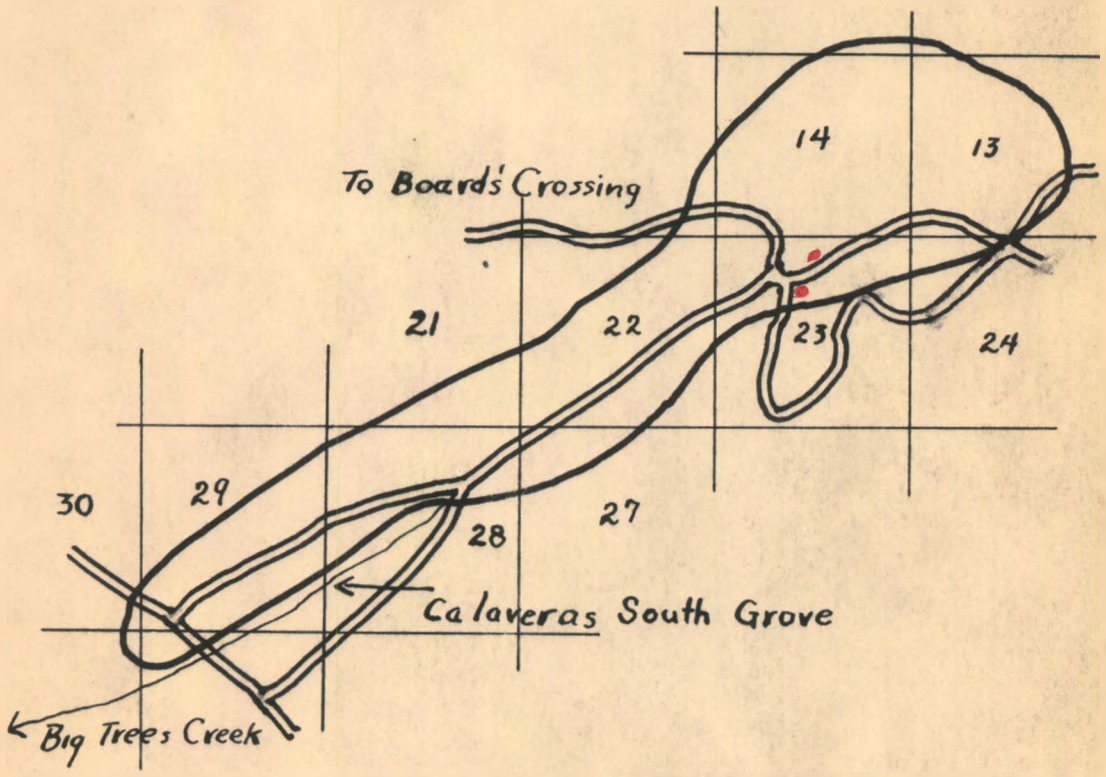
R 17 E T 3 N

Sec. 26



Stanislaus Tussock Moth Project
Thunder Hill Unit
July 5, 1956

1" = 1 mile



● = location of Plots

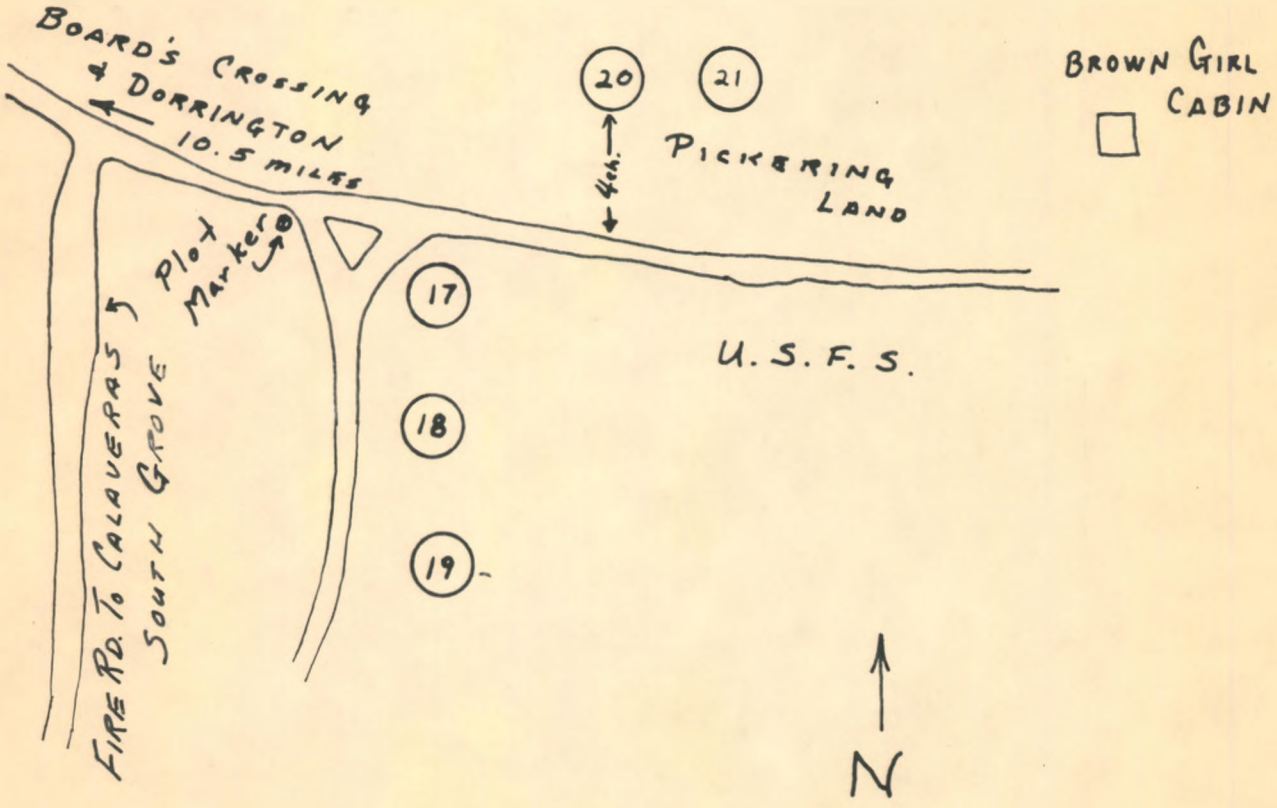
Tussock Moth Study

Location of Plots 17-21

Thunder Hill Unit

R. 16 E., T. 5 N.

Sec. 23

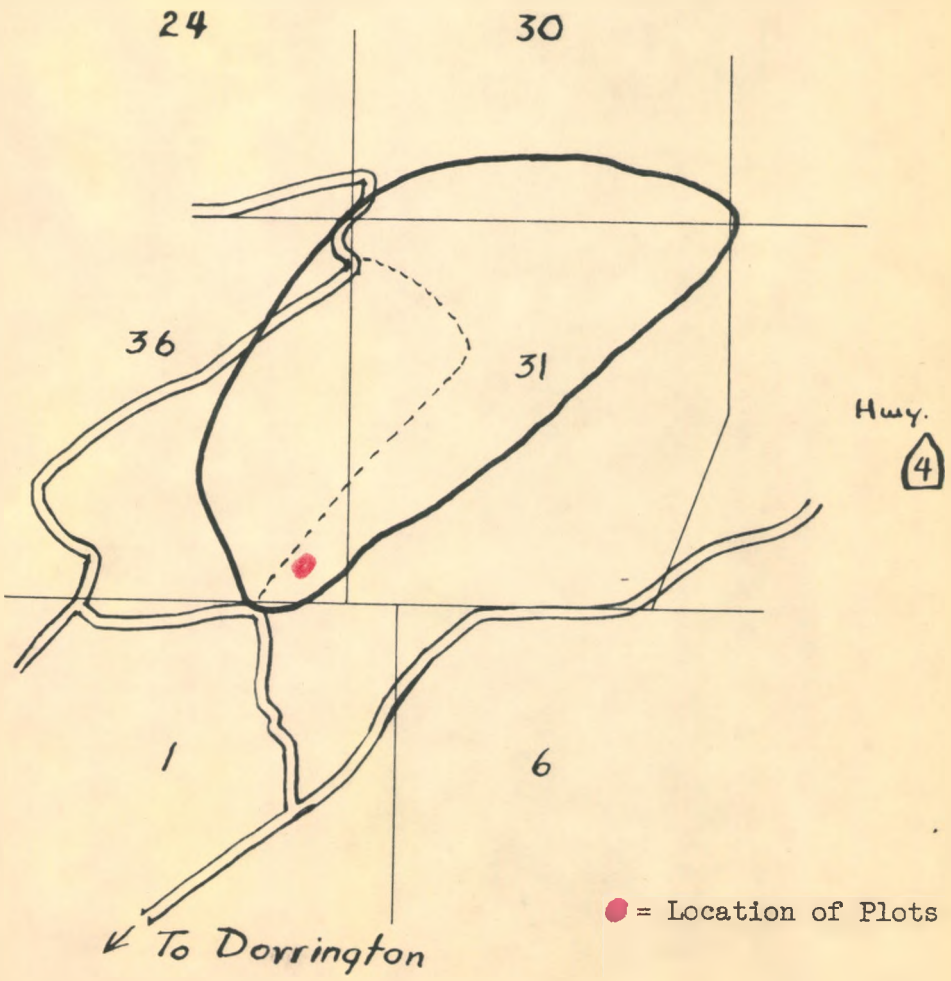


Stanislaus Tussock Moth Project

Summit Level Ridge Unit

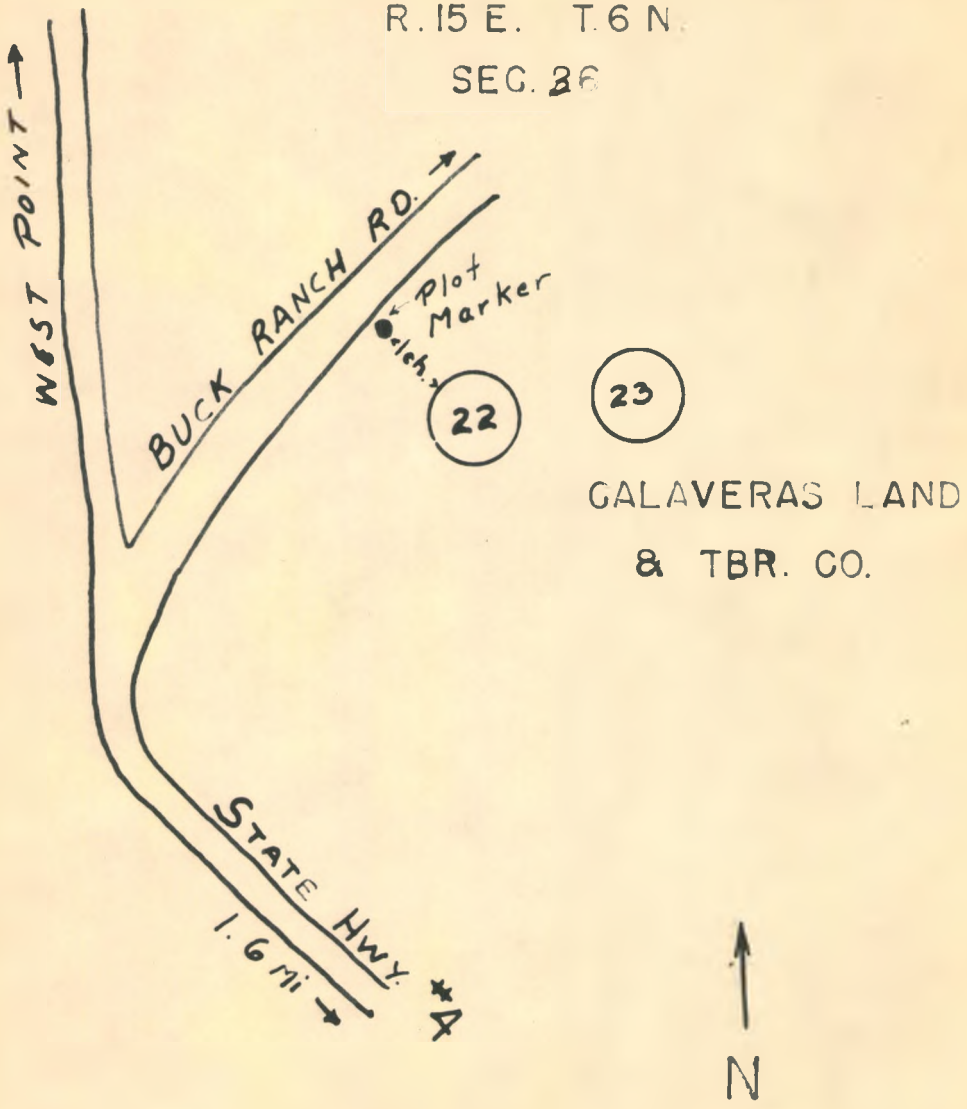
July 5, 1956

2" = 1 mile



TUSSOCK MOTH STUDY - LOCATION OF PLOTS 22-23

SUMMIT LEVEL RIDGE UNIT



S A M P L E

TUSSOCK MOTH DEFOLIATION STUDY

Plot No. 22 Page No. 1

Defoliation Intensity Light Established by BEW, JZ, JT, JV Date 8/9/56

Tree no.	Tree species	D.b.h.	Crown class	% Defol. 1956	Percent of crown killed 1956	1957	1958	1959	1960	Tree killed by	year
1	WF	19.1	CD	10	-						
2											
3											
4											
5											
--											
--											
--											
Sub Plot											
1	WF	5.2	S	5							
2											
3											
4											

DOUGLAS-FIR TUSSOCK MOTH STUDY

Location of Patterson's 1937 Study Plot

Inyo National Forest - T3S, R27E, Sec. 24